inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

INTELLIGIBILITY IN A SCHOOL IN LEÓN (SPAIN)

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ABSTRACT
The following information refers to a complete study of intelligibility carried out by the Acoustic Laboratory of the University of León in "Juan del Enzina" High School, in León (Spain). Thirty-three classrooms in a school were studied in two different phases of work. In the first study the RASTI Index was used, while in the second phase an analysis was made of the response of the pupils to a test carried out using lists of two-syllable words in which the emission levels were progressively changed in order to observe the variation in intelligibility. In addition, a sonometer study was realized, by which the situation in the school as to existing "background noise" could also be tested.

1 - INTRODUCTION
When a professor carries out his educational work facing a group of students of any level, he makes an effort to reach the natural objectives of apprenticeship making use of a great number of tools, but not all of the same importance. The word spoken is, by nature, essential in this process, and therefore is convenient to have the guarantee that the message it involves is transmitted with the neatest form possible among the subjects of the communication. For this purpose it is not sufficient with the clear emission of the message, upon seeing this modified, before its reception by the characteristic acoustics so much of the room as of the scene in which the process is developed. In this sense the presence of high fund noise levels or the scarce adaptation acoustics of the room may bring out some deficient conditions of intelligibility that complicate the basic educational purpose that is pursued in this type of installations [1].
Furthermore, it is of great interest to bring out the intelligibility acoustics' characteristics of the educational institutions in order to enabling the adaptation of the same to the uses for the ones that they were created.

2 - MATERIAL AND METHODS
"Juan del Enzina" High School is a teaching institution situated in the center of the city of León (Spain) in which they study secondary teaching students of ages between 14 and 18 years, distributed in four levels of teaching.
The Institute is found next to a street, which possesses an intense traffic to the hours in which the school activity is developed. However, the locating of the classrooms in the building is such that the classes are found oriented toward the interior patio, while the corridors and common zones are the ones that limit with the way traffic. The building comprises four plants with distinct distribution. The lower plant is utilized for laboratories, libraries or other uses and in the three remaining plants the classrooms, seminars and other services are found. The educational spaces of use in the building are: 30 classrooms, 4 laboratories, 5 seminaries, Gymnasium and Library. The study here reflected has been focused in the classrooms and laboratories by being the most representative educational spaces and by the interest shown by the professors of the teaching institution as for the improvement of the acoustic conditions.
The constructive characteristics of the classrooms and laboratories are similar, is a matter of variable spaces of volume with rectangular surface, limited among themselves by double walls of brick and regarding the playground by means of two large glassed windows.

Sonometer measures:
In order to determining the contribution of the noise of fund it was attacked a study of sonometría to obtain the parameters representative Leq, L10 and L90 measured with A balanced. The measures were carried out inside the academic schedule that covers since 8:30 till 14:30 and since the 16:30 till 22:30. Measurements of noise for each hour were taken inside the academic schedule, consistent in the execution of three measures for each classroom a minute average. The measures were done with the doors and windows closed and without students in the classroom. It was used the modular sonometer B&K 2231 + BZ7115, stationed in the middle of the classroom by means of a tripod to a height of 1,5 meters.
A selection of 6 classrooms, library and laboratory of Chemistry was done, seeking the best representative of the remainder of the educational spaces of each plant.

Objective method:
To determine the degree of intelligibility of the spoken word was applied the RASTI method (Rapid Speech Transmission Index), based on the measurement of the reduction of the modulation of the test's sign among the positions of the speaker and of the listener [2]. This method quantifies with rapidity the quality of intelligibility of a room by means of a scale of values that varies among 0 and 1. This test was carried out in all the educational spaces and in absence of students, although inside the academic schedule. The receiver was situated upon a tripod to a 1,5 m of height and forwards of the classroom where normally the teacher is standing. The receptor was placed stationed in several positions along the surface of the classroom, to a 1,2 m of the soil that is, the approximate height of a person sat down.
They were applied the equipment of measure B&K 4225 and 4419.

Subjective method:
Twelve lists of 25 words consisting of two modified syllables were applied (logotomos) proposed by Tato that contain very frequent phonemes in the Spanish language. The words were recorded with intervals of 3 seconds in a compact disk with two speakers. The tests were carried out with voluntary students not previously trained and sufficiently motivated. In each classroom collaborated among 20 and 30 students, who were the ones that habitually occupied it. They have at their disposal-colored patterns to note the lists of words that they heard. It was not taken in account the spelling when correcting the patterns, but in each position the registrations with intelligibility more less than the intelligibility average were eliminated less twice the typical deviation [3].
The emission of the lists was done with five different levels:

Series	*LAeq (dBA)*
1^a	42,9
2^a	45,3
3^a	51,2
4^a	57,4
5^a	61,2

Table 1.

3 - ANALYSIS OF RESULTS

The fund noise levels averaged for the entire academic schedule for morning and afternoon and measured in 8 classrooms are the ones that are reflected in the table 2.
It is appreciated that the values of LAeq do not exceed in any case the 37 dBA and that the levels of the afternoon schedule exceed to the ones in the morning.

CLASSROOMS	L_{Aeq}, Morning schedule	L_{Aeq}, Afternoon schedule
Lab. Chemistry (B-3)	33,0	33,7
Library (B-6)	30,1	28,7
Classroom 1-1	33,1	36,5
Classroom 1-5	32,1	34,0
Classroom 2-4	32,5	36,0
Classroom 2-7	33,8	34,9
Classroom 3-5	31,5	35,0
Classroom 3-8	33,6	35,5
AVERAGE	**32,5**	**34,3**

Table 2: Fund noise levels for periods of mornings and afternoons.

It must be emphasized that RASTI measures were carried out in absence of students. Therefore it was not kept in mind the absorption that these would contribute neither the increment in the noise of fund that the occupation of the classroom would involved [4].

In agreement with the characteristics of the classrooms a classification was done considering the indices RASTI of the following form:

Classification	*Rasti*
V. P. (Very Poor)	0 until 0,30
P (Poor)	0,31 until 0,45
W (Weak)	0,46 until 0,60
G (Good)	0,61 until 0,75
E (Excellent)	0,76 until 1,00

Table 3.

Subjective method:

There were carried out tests in 27 classrooms with educational activity and with the contribution of properly informed and trained students. The medium values of the intelligibility subjective index obtained vary with the series of emissions in classrooms, being the ones that are presented in the table 4. The indices keep an extensive rank of variation from very deficient values of 0,67 until values of 0,93 that would be able to be considered adequate. We must emphasize that there is not observed a good correlation among the Rasti indices obtained and its corresponding subjective indices for the same classrooms. This is due to the increment of noise fund, which is a consequence of the presence of the students in their respective classrooms.

Room	*B-5*	*1-1*	*1-2*	*1-3*	*1-4*	*1-5*	*1-6*	*1-7*	*2-2*	*2-3*	*2-4*	*2-5*	*2-6*	*2-7*
Medium Index	0,72	0,74	0,79	0,79	0,79	0,80	0,82	0,74	0,86	0,82	0,67	0,78	0,74	0,82

Room	*2-8*	*2-10*	*2-11*	*2-12*	*3-1*	*3-2*	*3-3*	*3-4*	*3-5*	*3-6*	*3-7*	*3-8*	*3-9*	
Medium Index	0,78	0,81	0,93	0,72	0,79	0,74	0,81	0,71	0,76	0,84	0,71	0,77	0,77	

Table 4: Subjective middle indices in the classrooms for the five levels of emission.

4 - CONCLUSIONS

All the classrooms studied possess an objective Poor (P) or Weak (W) intelligibility, which make them inefficient from the educational point of view The RASTI indices are found under 0,6 (0,44 is its medium value), affected by the high times of reverberation in these uses and volumes (medium value 2,02 seconds in 2 kHz).

As for the tests of subjective intelligibility, as it was expected, its index enlarged as well as the sonorous level of pressure of the emission until reaching values next to the 90%. However from 57 dBA in advance an effect of saturation, which is produced provokes in many cases a new fall in the indices of intelligibility. This indicates that the optimum level of emission of the speaker in order to obtain the maximum intelligibility in the present conditions is found among 51 and 57 dBA.

The environmental levels of noise barely have influence in lower intelligibility being the LAeq for the diurnal period under 34 dBA and for the vespertino under 37 dBA. This is due to the interior distribution of the corridors that they act as a barrier among the classrooms and the traffic ways.

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